

CLAIMS

1. A combined scanning probe and optical microscope comprising:

a sample stage defining an upper surface and a lower surface;

a scanning probe microscope configured to examine a surface of a sample supported by
said upper surface of said sample stage from above said sample stage;

an optical microscope configured to examine a sample supported by said upper surface of
said sample stage from below said sample stage;

a microscope coupling mechanically coupling elements of said scanning probe
microscope to elements of said optical microscope; and

a sample stage support configured to isolate said sample stage from said optical
microscope, wherein

said sample stage, said scanning probe microscope, and said sample stage
support define relatively high frequency mechanical resonances,

said optical microscope defines relatively low frequency mechanical
resonances, and

said microscope coupling, said sample stage, and said sample stage
support are arranged to inhibit differential motion between said sample stage and
said scanning probe microscope in the event of low frequency vibrations in said
optical microscope.

2. A combined scanning probe and optical microscope as claimed in claim 1 wherein said
combined scanning probe and optical microscope is designed such that a critical path coupling
low frequency vibrations generated in said optical microscope to a sample supported by said
sample stage runs from said optical microscope, through said microscope coupling, said sample
stage support, and, finally, to said sample stage.

3. A combined scanning probe and optical microscope as claimed in claim 2 wherein said sample stage support and said sample stage are designed such that said critical path is not conducive to low frequency vibrational coupling.

5 4. A combined scanning probe and optical microscope as claimed in claim 1 wherein said scanning probe microscope, said optical microscope, and said microscope coupling define a microscope chassis and wherein said sample stage support is configured to function as the sole significant source of vibro-mechanical coupling between said sample stage and said microscope chassis.

10 5. A combined scanning probe and optical microscope as claimed in claim 1 wherein said sample stage support includes a plurality of suspension members extending from said microscope coupling and each of said suspension members defines a distal end configured to support said sample stage.

15 6. A combined scanning probe and optical microscope as claimed in claim 5 wherein each of said suspension members comprises a rigid shaft configured to define a relatively high frequency bending moment.

20 7. A combined scanning probe and optical microscope as claimed in claim 5 wherein each of said plurality of suspension members comprises an adjustable rigid screw and a magnetic ball secured to a distal end of said screw.

25 8. A combined scanning probe and optical microscope as claimed in claim 7 wherein said adjustable rigid screw is engaged in a threaded bore in said microscope coupling.

9. A combined scanning probe and optical microscope as claimed in claim 1 wherein said microscope coupling includes a movable stage assembly and wherein said movable stage assembly is arranged to permit controlled movement of said sample stage and said sample stage support relative to said optical microscope.

10. A combined scanning probe and optical microscope as claimed in claim 1 wherein said microscope coupling is mounted to a movable stage assembly and wherein said movable stage assembly is arranged to permit movement of said sample stage and said sample stage support relative to said optical microscope.

11. A combined scanning probe and optical microscope as claimed in claim 10 wherein said movable stage assembly comprises a slide-mounted stage assembly arranged to permit slidable movement of said sample stage and said sample stage support relative to said optical microscope.

12. A combined scanning probe and optical microscope as claimed in claim 10 wherein said movable stage assembly defines a range of movement sufficient to enable movement of said sample stage away from said optical microscope.

13. A combined scanning probe and optical microscope as claimed in claim 10 wherein said movable stage assembly defines a range of movement sufficient to enable removal and replacement of said sample stage independent of said optical microscope.

14. A combined scanning probe and optical microscope as claimed in claim 10 wherein said optical microscope, said scanning probe microscope, and said microscope coupling define a sample stage enclosure and wherein said movable stage assembly defines a range of movement sufficient to enable movement of said sample stage outside of said sample stage enclosure.

15. A combined scanning probe and optical microscope as claimed in claim 1 wherein said scanning probe microscope includes a cantilever unit positioned above said sample stage and comprising:

- a flexible cantilever having a free end and a confined end; and
- a probe tip defined at said free end of said flexible cantilever.

16. A combined scanning probe and optical microscope as claimed in claim 15 further comprising a solenoid unit positioned above said cantilever unit and comprising a magnetic core and a solenoid winding, wherein said solenoid unit is configured to cause movement of said free end of said flexible cantilever.

17. A combined scanning probe and optical microscope as claimed in claim 16 wherein said cantilever unit is mechanically coupled to said magnetic core of said solenoid unit.

18. A combined scanning probe and optical microscope as claimed in claim 16 wherein said cantilever unit is secured proximate to said magnetic core of said solenoid unit.

19. A combined scanning probe and optical microscope as claimed in claim 16 wherein said cantilever unit is secured to said magnetic core of said solenoid unit.

20. A combined scanning probe and optical microscope as claimed in claim 16 wherein said magnetic core defines an extended portion outside of said solenoid winding and wherein said cantilever unit is mechanically coupled to said extended portion of said magnetic core.

21. A combined scanning probe and optical microscope as claimed in claim 16 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to an upper side of said cantilever unit and wherein said magnetic core and said solenoid winding are positioned above said cantilever unit.

22. A combined scanning probe and optical microscope as claimed in claim 16 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to said free end of said flexible cantilever.

23. A combined scanning probe and optical microscope as claimed in claim 22 wherein said solenoid winding is wound about portions of said optically transparent element and said magnetic core.

24. A combined scanning probe and optical microscope as claimed in claim 22 wherein said optically transparent element is a glass block or a hollow tube.

25. A combined scanning probe and optical microscope as claimed in claim 16 wherein:
said cantilever unit further comprises a cantilever support chip; and
said cantilever support chip is secured to said magnetic core of said solenoid unit.

26. A combined scanning probe and optical microscope as claimed in claim 16 wherein said cantilever unit is releasably secured to said magnetic core.

27. A combined scanning probe and optical microscope as claimed in claim 26 wherein said cantilever unit is secured to said magnetic core by means of a spring-loaded strap.

28. A combined scanning probe and optical microscope as claimed in claim 26 wherein said cantilever unit is secured to said magnetic core by means of a releasable clip.

29. A scanning probe microscope comprising:

a sample stage;

a scanning probe microscope supported by a microscope chassis and configured to
examine a surface of a sample supported by said sample stage;

5 a microscope coupling supporting elements of said scanning probe microscope;

a sample stage support configured to suspend said sample stage from said microscope
coupling; and

a slide-mounted stage assembly arranged to permit slidable movement of said sample
stage and said sample stage support relative to said microscope chassis.

10

30. A scanning probe microscope as claimed in claim 29 wherein said slide-mounted stage
assembly is further arranged to permit slidable movement of said scanning probe microscope
relative to said microscope coupling.

15

31. A scanning probe microscope as claimed in claim 29 wherein said slide-mounted stage
assembly defines a range of movement sufficient to enable movement of said sample stage away
from said microscope coupling.

20

32. A scanning probe microscope as claimed in claim 29 wherein said slide-mounted stage
assembly defines a range of movement sufficient to enable removal and replacement of said
sample stage independent of said microscope coupling.

25

33. A scanning probe microscope as claimed in claim 29 wherein said scanning probe
microscope and said microscope coupling define portions of a sample stage enclosure and
wherein said slide-mounted stage assembly defines a range of movement sufficient to enable
movement of said sample stage outside of said sample stage enclosure.

34. A scanning probe microscope comprising a sample stage, a scanning probe microscope configured to examine a surface of a sample supported by said sample stage, a microscope coupling, and a sample stage support configured to suspend said sample stage from said microscope coupling, wherein said scanning probe microscope includes a solenoid driven cantilever assembly comprising:

a cantilever unit positioned above said sample stage and comprising a flexible cantilever having a free end and a confined end;

a probe tip defined at said free end of said flexible cantilever; and

a solenoid unit positioned above said cantilever unit and comprising a magnetic core and a solenoid winding, wherein said solenoid unit is configured to cause movement of said free end of said flexible cantilever.

35. A scanning probe microscope as claimed in claim 34 wherein said cantilever unit is mechanically coupled to said magnetic core of said solenoid unit.

36. A scanning probe microscope as claimed in claim 34 wherein said cantilever unit is secured proximate to said magnetic core of said solenoid unit.

37. A scanning probe microscope as claimed in claim 34 wherein said cantilever unit is secured to said magnetic core of said solenoid unit.

38. A scanning probe microscope as claimed in claim 34 wherein said magnetic core defines an extended portion outside of said solenoid winding and wherein said cantilever unit is mechanically coupled to said extended portion of said magnetic core.

39. A scanning probe microscope as claimed in claim 34 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to an upper side of said cantilever unit and wherein said magnetic core and said solenoid winding are positioned above said cantilever unit.

5

40. A scanning probe microscope as claimed in claim 34 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to said free end of said flexible cantilever.

10

41. A scanning probe microscope as claimed in claim 40 wherein said solenoid winding is wound about portions of said optically transparent element and said magnetic core.

15

42. A scanning probe microscope as claimed in claim 40 wherein:
said cantilever unit further comprises a cantilever support chip; and
said cantilever support chip is secured to said magnetic core of said solenoid unit.

20

43. A scanning probe microscope as claimed in claim 40 wherein said cantilever unit is releasably secured to said magnetic core.

25

44. A solenoid driven cantilever assembly comprising:
a cantilever unit comprising a flexible cantilever having a free end and a confined end;
a probe tip defined at said free end of said flexible cantilever, said probe tip defining an apex on a lower side of said cantilever unit; and
a solenoid unit positioned above said cantilever unit and comprising a magnetic core and a solenoid winding, wherein said solenoid unit is configured to cause movement of said free end of said flexible cantilever.

45. A scanning probe microscope as claimed in claim 44 wherein said cantilever unit is mechanically coupled to said magnetic core of said solenoid unit.

46. A scanning probe microscope as claimed in claim 44 wherein said cantilever unit is secured proximate to said magnetic core of said solenoid unit.

47. A scanning probe microscope as claimed in claim 44 wherein said cantilever unit is secured to said magnetic core of said solenoid unit.

48. A scanning probe microscope as claimed in claim 44 wherein said magnetic core defines an extended portion outside of said solenoid winding and wherein said cantilever unit is mechanically coupled to said extended portion of said magnetic core.

49. A scanning probe microscope as claimed in claim 44 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to an upper side of said cantilever unit and wherein said magnetic core and said solenoid winding are positioned above said cantilever unit.

50. A scanning probe microscope as claimed in claim 44 wherein said solenoid driven cantilever assembly further comprises an optically transparent element arranged to pass light to said free end of said flexible cantilever.

51. A scanning probe microscope as claimed in claim 50 wherein said solenoid winding is wound about portions of said optically transparent element and said magnetic core.

52. A scanning probe microscope as claimed in claim 44 wherein:
said cantilever unit further comprises a cantilever support chip; and
said cantilever support chip is secured to said magnetic core of said solenoid unit.

Docket No. - MOL 0063 PA
Title - SCANNING PROBE MICROSCOPE AND
SOLENOID DRIVEN CANTILEVER ASSEMBLY
Inventor(s) - Lindsay and Jing

53. A scanning probe microscope as claimed in claim 44 wherein said cantilever unit is releasably secured to said magnetic core.

FIG. 10 is a schematic diagram of the scanning probe microscope and solenoid driven cantilever assembly.